

ON DISTINGUISHING *TRUPANEA BISETOSA* (COQUILLET) FROM  
*T. NIGRICORNIS* (COQUILLET) (DIPTERA: TEPHRITIDAE)

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*Abstract.*—Males of *Trupanea bisetosa* (Coquillett) and *T. nigricornis* (Coquillett) are readily separated morphologically. Most (ca. 70–80%) females of these sexually dimorphic species can be distinguished by the shape of the apical Y-shaped mark in the wing. This mark is squat and thick-based in most *T. bisetosa* females and stretched and thin-based in most *T. nigricornis* females. *Trupanea bisetosa* also has a much narrower range of host plants than *T. nigricornis* in southern California. The former mainly infests capitula of *Helianthus* spp.; whereas, *T. nigricornis* is polyphagous on many different species of Asteraceae. *Trupanea nigricornis* also is more common and widespread in desert areas than *T. bisetosa*. Behavioral differences of adults in insectary cagings are reported, chief among which was the observation that *T. bisetosa* mated in the early morning and *T. nigricornis* in the afternoon. Cross-matings of these species yielded fertile eggs in confined cagings.

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In studying the life history of *Trupanea bisetosa* (Coquillett) on the sunflower, *Helianthus annuus* L., in southern California (Cavender and Goeden, 1982), we early encountered the problem of separating the females of this species from those of *T. nigricornis* (Coquillett)—a problem which vexed Foote (1960) as well. We approached its solution by studying separate samples of these flies reared from capitula of different Asteraceae. This paper reports our findings on the morphological, ecological, and biological separation of these sexually dimorphic species in southern California.

MORPHOLOGY

Foote (1960) noted that the male of *T. nigricornis* is easily recognized by the very dark yellow to black third antennal segment; the distinctly quadrate infuscated spot posterior to the stigma; the presence of a distinct spot centered on vein  $M_3 + Cu_1$ ; and the absence of the posterior arm of the apical Y-shaped mark. In the male of *T. bisetosa*, the third antennal segment is yellow; the infuscated spot posterior to the stigma is slanted towards vein  $m$ ; there is no dark spot on vein  $M_3 + Cu_1$ ; and the apical Y-shaped mark is uninterrupted. However, Foote (1960) failed to detect any satisfactory means of separating the females of these two species. Foote and Blanc (1963) similarly noted that the females were not separable.

We restricted our morphological examinations to intact, point-mounted spec-

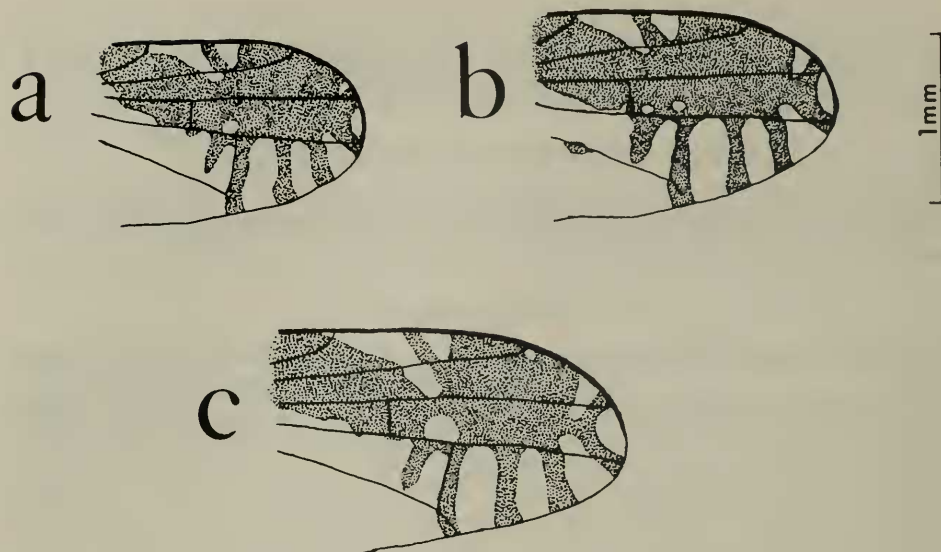


Fig. 1. a, Wing of female *T. bisetosa* showing squat, apical Y-shaped mark. b, Wing of female *T. nigricornis* with intermediate shaped, apical Y-shaped mark. c, Wing of female *T. nigricornis* showing stretched, apical Y-shaped mark.

imens reared as both males and females from capitula of each of several species of Asteraceae in southern California during 1979–82. Of 71 *T. bisetosa* males reared from capitula of *H. annuus*, all had yellow third antennal segments; two (2.8%) showed slight breaks in the posterior arm of the apical Y-mark; two (2.8%) other specimens had faint spots in the center of vein  $M_3 + Cu_1$ ; and two (2.8%) other specimens had subquadrate, infuscated spots posterior to the stigma. Of 71 *T. nigricornis* males reared from capitula of *Encelia farinosa* Gray ex Torrey, all had very dark to black third antennal segments and a quadrate infuscated spot posterior to the stigma; one (1.4%) had a complete, but attenuated posterior arm on the apical Y-mark; but only 13 (18%) had a faint to prominent dark spot centered on vein  $M_3 + Cu_1$ . Thus, with the exception of the character involving the spot on vein  $M_3 + Cu_1$ , the characteristics by which Foote (1960) and Foote and Blanc (1963) separated the males of these species proved useful with our material. Only 13 (12.3%) of a total of 106 males of *T. nigricornis* reared from capitula of 15 of the host-plant species besides *E. farinosa* reported below had such a spot, however narrow and light, centered on vein  $M_3 + Cu_1$ . This character was not associated with males reared from any particular host, as these 13 males were reared from six different plant species representing five separate genera.

One means was found by which most females can be separated morphologically as intact specimens. This involves the gross appearance of the apical Y-shaped mark on the wing, which usually is squat and thick-based (ca.  $2\times$  width of the posterior, apical arm) in *T. bisetosa* and stretched and thin-based (ca. = width of the posterior, apical arm) in *T. nigricornis* (Fig. 1). Of 57, presumably all *T. bisetosa* females reared from *H. annuus* capitula in the presence of *T. bisetosa* males and the absence of *T. nigricornis* males, 41 (71.9%) had squat, apical

Y-marks, one (1.8%) had a stretched, apical Y-mark, and 15 (26.3%) were intermediate for this character with *T. nigricornis* females (Figs. 1a, b). Of 57, presumably all *T. nigricornis* females reared from capitula of *E. farinosa* in the presence of *T. nigricornis* males and the absence of *T. bisetosa* males, 41 (71.9%) had stretched, apical Y-marks and 16 (28.1%) were intermediate for this character with *T. bisetosa* females (Figs. 1b, c). Of a total of 101 *T. nigricornis* females reared from capitula of 14 of the host-plant species besides *E. farinosa* reported below, 83 (82.2%) had stretched, apical Y-marks and the remainder were intermediate with *T. bisetosa* females for this character.

In addition to these wing differences, minor but consistent differences were found by R. H. Foote (in litt.) in the postabdomens of the females of these two species, probably a reflection of the differences in their host preferences.

#### HOST PLANTS

*Trupanea nigricornis* attacks a much wider range of Asteraceae and different hosts than *T. bisetosa* in southern California. The junior author (RDG) has reared *T. nigricornis* from capitula of the following Asteraceae collected where noted on the dates indicated (new host-plant records according to Wasbauer (1972) are marked with an asterisk (\*) and follow the nomenclature of Munz (1974)): *Acamp-topappus sphaerocephalus* (Harvey and Gray) Gray\*, Snow Creek, Riverside Co., III-7-81, 2 ♂; *Baccharis sergiloides* Gray\*, Howe Spring, New York Mts., San Bernardino Co., IX-9-81, 1 ♂, 2 ♀; *Chrysothamnus nauseosus* (Pallas) Britton ssp. *hololeucus* (Gray) Hall and Clements\*, Caruthers Canyon, New York Mts., San Bernardino Co., IX-22-81, 12 ♂, 3 ♀; *Encelia farinosa*, Blythe, Riverside Co., III-17-81, 61 ♂, 62 ♀; *E. frutescens* Gray\*, Zzyxx Road, NE San Bernardino Co., IV-29-81, 8 ♂, 9 ♀; *E. virginensis* A. Nelson\*, Cima, San Bernardino Co., IV-30-81, 3 ♂, 4 ♀; *Haplopappus acradenius* (Greene) Blake ssp. *eremophilus* (Greene) Hall\*, Mountain Springs, Imperial Co., X-14-81, 1 ♂, 1 ♀; *H. laricifolius* Gray\*, Cedar Canyon, NE San Bernardino Co., IX-9-81, 13 ♂, 8 ♀; *H. venetus* (Humboldt) Blake ssp. *oxyphyllus* (Greene) Hall\*, McCain Valley, San Diego Co., X-16-80, 4 ♂, 2 ♀; *H. v.* ssp. *vernonoides* (Nuttall) Hall\*, Cardiff-by-the-Sea, San Diego Co., X-15-80, 2 ♂; *Lepidospartum squamatum* (Gray) Gray\*, Cajon Junction, San Bernardino Co., IX-2-81, 13 ♂, 13 ♀; *Peucephyllum schottii* (Gray) Gray\*, Bradshaw Trail, Riverside Co., II-11-81, 17 ♂, 6 ♀; *Solidago californica* Nuttall\*, Kitchen Creek, San Diego Co., IX-9-80, 1 ♀; *S. occidentalis* (Nuttall) Torrey and Gray\*, Kennedy Meadows, Tulare Co., IX-26-80, 5 ♂, 5 ♀; *Viguiera deltoidea* Gray var. *parishii* (Greene) Vasey and Rose\*, Chino Canyon, Riverside Co., IV-3-80, 15+ ♂, 15+ ♀. Additional records involving fewer adults reared from these plant species at other locations are not reported. Also, the *T. nigricornis* reported at *T. bisetosa* from *Ambrosia dumosa* (Gray) Payne and *A. ilicifolia* (Gray) Payne in southern California by Goeden and Ricker (1976a, 1976b) were misidentified on the basis of what was known of these two species of *Trupanea* at the time.

The senior author (GLC) has commonly reared *T. bisetosa* from capitula of wild and cultivated varieties of *H. annuus* and from *H. ciliaris* Décandolle (Cavender and Goeden, 1982) in southern California. The junior author (RDG) has reared *T. bisetosa* from capitula of two additional Asteraceae collected as follows: *Geraea canescens* Torrey and Gray\*, Hidden Springs, Riverside Co., IV-14-81, 2 ♂; *Helianthus niveus* (Bentham) Brandegees ssp. *tephrodes* (Gray) Heiser\*, Sand

Hills at Glamis, Imperial Co., I-28-82, 8 ♂, 10 ♀. Thus, *T. bisetosa* apparently is much more restricted in its choice of host plants and shows a marked affinity for *Helianthus* spp. Its incidence in capitula of the so-called "desert sunflower," *G. canescens*, an ephemeral, desert annual (Munz, 1974), was rare and greatly subordinated to 73 *Neotephritis finalis* (Loew) reared from the same sample.

Published host-plant records for *T. bisetosa* and *T. nigricornis* (Wasbauer, 1972) are confused. Cavender and Goeden (1982) suggested that most records for *T. bisetosa* contained in Wasbauer (1972) probably were misidentifications of *T. nigricornis* or suspect "unpublished records" that need verification. Wasbauer (1972) listed *Baccharis glutinosa* Persoon, *Brikellia* [sic] *arguta* Robinson, *Carthamnus tinctorius* L., *Chrysothamnus nauseosus* ssp. *glabratus* [?], *Chrysothamnus viscidiflorus* (Hooker) Nuttall, *Encelia californica* Nuttall, *E. farinosa*, *Helianthella* sp., *Perezia microcephala* (Décandolle) Gray as host plants of *T. nigricornis*. The new rearing records reported herein confirmed the affinities of this polyphage for several of these host-plant genera. The junior author (RDG) has reared *T. wheeleri* Curran in large numbers, e.g., 128 and 52 flies/sample, from capitula of *E. californica* collected at three widely separated, coastal locations (unpublished data), but never *T. nigricornis*, which suggests that this published, "unpublished," California record for the latter tephritid (Wasbauer, 1972) may have been atypical.

#### DISTRIBUTION

Distribution maps for *T. bisetosa* and *T. nigricornis* in Foote and Blanc (1963) indicate that these species are sympatric in southern California. Our rearing records confirmed this, but also suggested that *T. nigricornis* is by far the more common and widespread species, like many of its host plants (Munz, 1974). The distribution map for *T. bisetosa* in Foote and Blanc (1963) was based in part on many records for females swept singly or in small numbers without males from non-host plants in desert areas. Most of these specimens probably were *T. nigricornis*. *Trupanea bisetosa* was reared by one of us (RDG), as reported above, only from two localized species of Sonoran (low elevation) desert plants, never from the native, Mojave (high elevation) Desert Asteraceae sampled during 1979–81, and only from *Helianthus* spp. in coastal and interior valleys in southern California (Cavender and Goeden, 1982). Indeed, up until the time of this writing, when *T. bisetosa* first was reared from *H. niveus* capitula as reported above, this tephritid was considered by us normally not to be a desert species (Cavender and Goeden, 1982). Field data as yet are insufficient to explain these distributional patterns for *T. bisetosa* in southern California, though we suspect that seasonal migrations by adults are involved.

#### BIOLOGY

Behavioral differences and similarities were observed in insectary cagings of *T. bisetosa* and *T. nigricornis* adults at  $26 \pm 1^\circ\text{C}$ , 30–60% RH, and a 12-h photophase from 0500 to 1700 h. The behavior of these flies are compared in Table 1 in the manner of Tauber and Toschi (1965). Cavender and Goeden (1982) presented a detailed account of the adult behavior of *T. bisetosa* from which these tabulated data are extracted in part.

The principal difference in the behavior of these two species was their time of

Table 1. Comparison of generalized behavior of *T. bisetosa* and *T. nigricornis* adults in the insectary.

| Description of Behavior <sup>1</sup>                      | <i>T. bisetosa</i> <sup>1</sup>  | <i>T. nigricornis</i>  |
|---|--|--|
| Premating behavior  | Wings of male vibrate while brought forward in unison, to ca. 90° with body; alternating with walking-in-spurts towards female | Wings of male flutter while brought forward in unison, to ca. 45° with body; otherwise, the same                       |
| When mating behavior observed                             | Early morning (0525 to 0800 h)   | Afternoon (1330 to 1630 h)   |
| Copulatory positions:                                     |  |  |
| Head of male  | Above and behind juncture of abdomen and thorax, well behind scutellum of female   | More posterior along abdomen of female   |
| Rostrum of male   | Alternately extended and retracted, but labellum not touching female   | Same, but labellum touching dorsum of abdomen of female  |
| Wing position   | Male: fully overlapped with occasional alternate wing movements; female: spread apart ca. 45°                                  | Male: only slightly overlapped, without alternate wing movements; female: same   |
| Position of foretarsi                                     | Along pleura of anterior part of abdomen of female   | Same   |
| Position of mesotarsi                                     | On posterior part of pleura of abdomen of female   | Just behind foretarsi on pleura of abdomen of female   |
| Position of metatarsi                                     | Hanging free behind abdomen of female, often rubbing together  | Hanging down and touching the substrate  |
| Ovipositor telescoped outward                             | +  | ?  |
| Points of contact   | Genitalia; fore- and mesotarsi of male on abdominal pleura of female; foretibia of male on anal margin of wing of female       | Genitalia; fore- and mesotarsi of male on abdominal pleura of female; mouthparts of male to abdominal dorsum of female |
| Postmating behavior                                       | Wings of male held outward at 90° and abdominal pleura distended outward   | None observed  |
| Male homosexual behavior                                  | Males court and mount males  | Same   |
| Defensive behavior against intruding flies of same sex    | Males and females wave forelegs and alternately wave wings at intruders  | Males and females wave forelegs at intruders; male holds both wings outward at 90° while facing intruder               |
| Alternate forward wing movements while at rest or walking | + (males and females)  | Same   |
| Windshield-wiper wing movements <sup>1</sup>              | + (males and females)  | + (males) ? (females)  |
| Both wings held outward at 90°                            | During postmating behavior (males)   | During defensive behavior (males)  |

<sup>1</sup> Described fully in Cavender and Goeden (1982) for *T. bisetosa*.

mating in the insectary (Table 1). In this regard, *T. bisetosa* mates earlier than has been reported for most species of Tephritidae (Bateman, 1972; Cavender and Goeden, 1982). This difference could help to isolate this species, if it also occurred in nature, as was unconfirmed during these studies. Other behavioral differences were noted (Table 1).

A simple experiment also was conducted in the insectary to determine whether these closely related species could cross. One-liter, plastic, ventilated cages, fully described elsewhere (Gilstrap and Goeden, 1974), contained young flowerheads of *H. annuus* and *E. farinosa* and mature virgin flies reared from isolated larvae and puparia dissected from field-collected capitula. Honey was striped on the inner wall of each cage for food and the absorbant cotton plug that secured each bouquet inserted into a water reservoir also acted as a wick and water source. Six cages held 1 ♂ *T. bisetosa* and 1 ♀ *T. nigricornis* each; six cages held 1 ♂ *T. nigricornis* and 1 ♀ *T. bisetosa*; three cages held 1 ♂ and 1 ♀ *T. bisetosa*; three cages held 1 ♂ and 1 ♀ *T. nigricornis* each; two cages contained 1 ♀ *T. bisetosa* each; and two cages held 1 ♀ of *T. nigricornis* each.

After four to five days, the caged flowerheads were examined for eggs, and these eggs for signs of embryonic development, i.e., the cephalopharyngeal skeleton, as evidence of successful mating. Briefly, the isolated females only laid infertile eggs. All three pairs of *T. bisetosa* yielded fertile eggs; two of the three *T. nigricornis* pairs produced fertile eggs, while the third female laid very few, infertile eggs. All six of the *T. bisetosa* females paired with *T. nigricornis* males laid fertile eggs. Two of the six *T. nigricornis* females paired with *T. bisetosa* males laid fertile eggs; two laid infertile eggs; and two laid no eggs. Thus, in confined cagings under insectary conditions these two species successfully crossmated. As larval development in these species only occurs in live capitula (Cavender and Goeden, 1982), these eggs were not reared past eclosion.

#### CONCLUSIONS

These results demonstrated that *T. bisetosa* and *T. nigricornis* are largely, but incompletely separable phenetic groups representing sympatric, potentially interfertile populations that are behaviorally and ecologically isolated reproductively, and, thus, valid species in southern California (Foote and Blanc, 1963; Doyen and Slobodchikoff, 1974). We have never reared males of both species from individual samples of capitula; although, such synphagy is a common characteristic of other California *Trupanea* (Goeden, unpublished data). Flowerheads of *H. annuus* and *E. farinosa* commonly growing in juxtaposition in disturbed chaparral in the Riverside area invariably yielded *T. bisetosa* and *T. nigricornis*, respectively, in insectary rearings (Cavender and Goeden, 1982; Cavender, unpublished data).

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